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Historical and Ecological Perspectives on Fire Activity in the Klamath Geological Province of the Rogue River and Siskiyou National Forests

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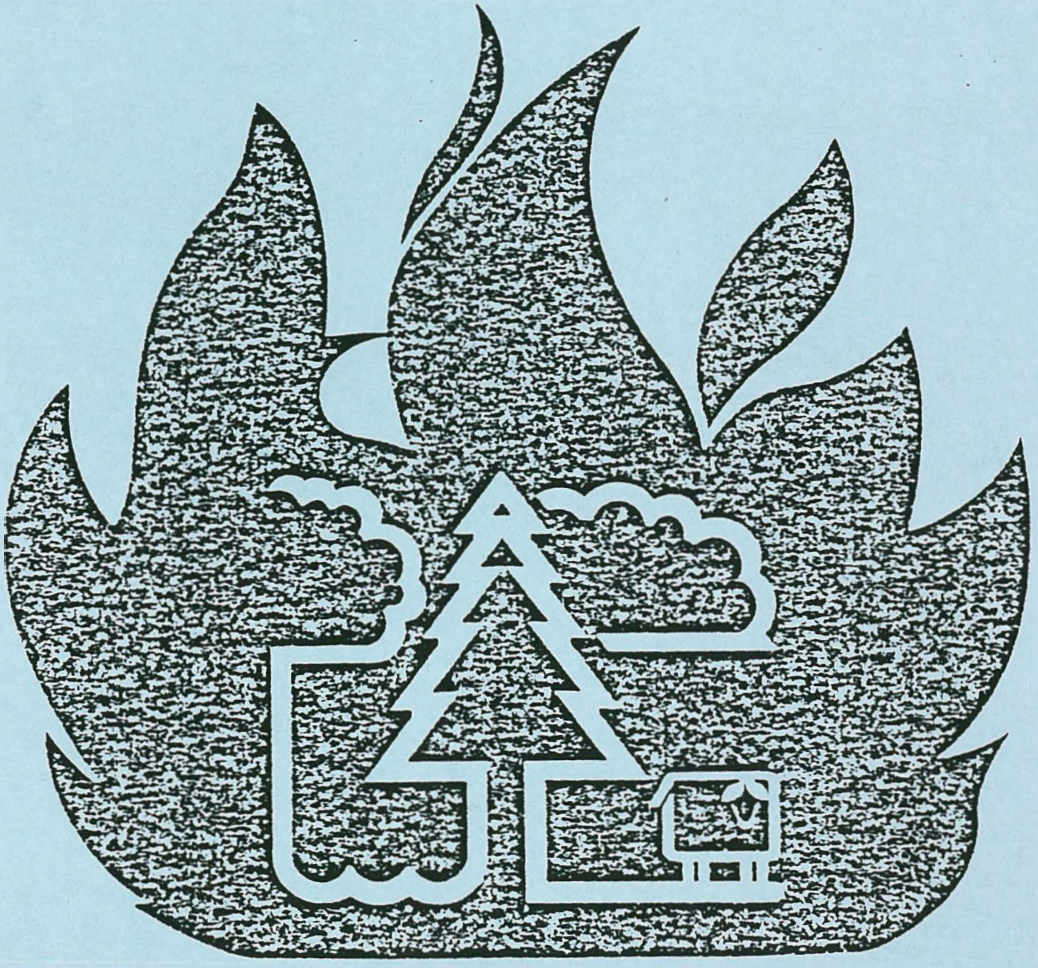

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HISTORICAL AND ECOLOGICAL PERSPECTIVES ON FIRE ACTIVITY IN THE KLAMATH GEOLOGICAL PROVINCE OF THE ROGUE RIVER AND SISKIYOU NATIONAL FORESTS

By

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I. INTRODUCTION

Plant associations are rarely a direct result of their average operative environment. More often their structure and composition are a function of intense periodic events. Flood, mass movement, ice storm, wind, epidemic and fire commonly dominate the successional processes. Fire, one of the most common and widespread periodic events, has been responsible for maintaining the dominance of seral species such as lodgepole pine, ponderosa pine and Douglas-fir. Recently the control and elimination of fire has allowed such fire sensitive species as hemlock, tanoak and white fir to replace these dominants.

Fire has had and will continue to have a profound effect on our plant associations. Thus, understanding fire history is essential to understanding plant community development and reaction to management activities. Detailed fire history studies have been completed in many areas of the Pacific Northwest but the Klamath Geological Province of southwestern Oregon has been ignored (Hall, 1977; Shinn, 1980; Vale, 1981; Arno, 1980; Hemstrom, 1980; McNeil and Zobel, 1980). Moreover, the uniqueness of the environment and vegetation in this area precludes extrapolation of results from other areas.

The objective of this paper is to present an overview of the ecology of the Province and its fire regime. The presentation is based on data collected from 997 permanent ecological plots established by the USDA Forest Service, Pacific Northwest Region, Area Ecology Program on the western portion of the Rogue River National Forest and the entire Siskiyou National Forest.

The Klamath Geological Province is complex geologically, climatologically, and floristically. The extreme variation results in several plant series occurring within the study area. Each series is characterized by its own fire occurrence, fire risk, and response to burning.

II. GEOGRAPHY OF SOUTHWESTERN OREGON

Much of southwestern Oregon is within the Klamath Geological Province (Cater and Wells, 1954). The province extends south into California and is bordered by the Cascades on the east, the ocean on the west, and a diagonal line from Gold Beach to Roseburg on the north (Figure 1). The Siskiyous are within this province and extend westward from Ashland to approximately Highway 199, bordered by Rush and Kirby on the north, and the Klamath River on the south. The area studied is larger and includes the coastal Siskiyou National Forest and the western portion of the Rogue River National Forest.

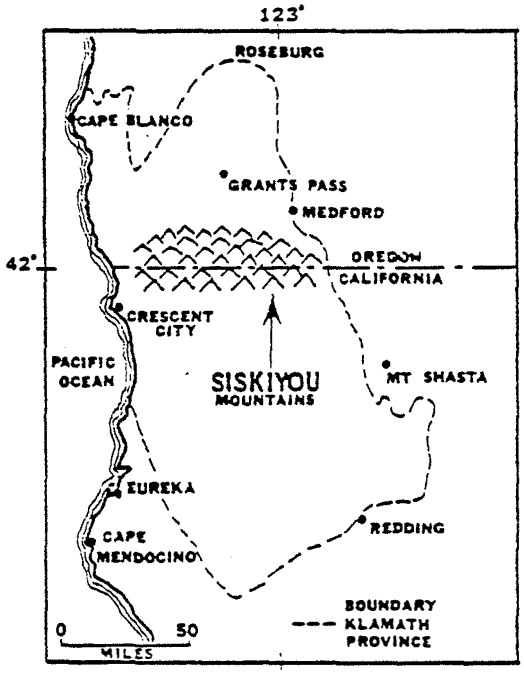


Figure 1 Map of the Klamath Geological Province showing the location of the Siskiyou Mountains.

III. CLIMATIC REGIME

The study area can be divided into five distinctly different climatic zones (Figure 2) based primarily on available summer moisture. Generally rainfall ranges from 380 cm (150 in) on the coastal crest to about 100 cm (40 in) on the driest eastern edge near Ashland. Two of the zones lie east of the Applegate/Illinois River divide. Waring (1969) recognized climatic differences between the Eastern and Western Siskiyous and used the absence of Sadler oak to indicate the drier Eastern climatic zone. His line dividing the two zones is from Grants Pass southeast to Condrey Mountain.

West of Waring's line precipitation gradually increases to about 230 cm (90 in) near Grayback Mountain and decreases to about 100 cm (40 in) in the Illinois Valley, the Rainshadow of the coastal crest (Figure 2). In this third zone the soil reservoir (below ground moisture) is extremely important as an environmental factor.

The remaining coastal climatic zones are characterized by summer precipitation and fog. This extremely important above ground moisture source masks soil differences, allowing moisture loving species to occur on shallow soils. The most northerly portion of the study area, the Coastal Fog Belt, receives considerably more fog and is cooler than the Coastal zone immediately south and the evapotranspirational demand is significantly lower. Western hemlock and western redcedar are common in this zone. The Rogue/Elk Rivers Divide separates the two coastal zones.

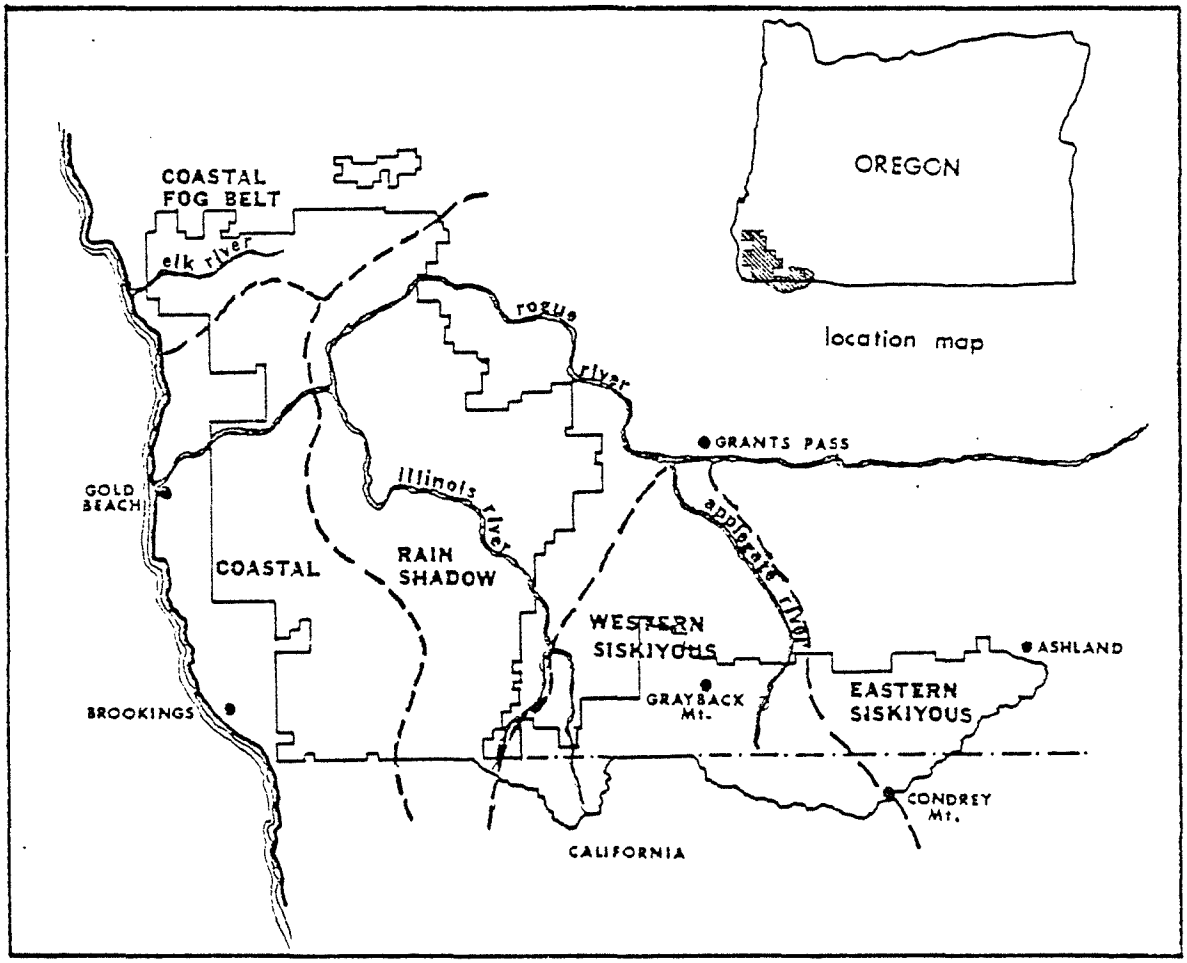


Figure 2 Broad climatic regimes of the Siskiyou and Coastal Mountains. (1) Waring's division of the eastern and western Siskiyous.

IV. HISTORICAL PERSPECTIVES

The Klamath Geological Province was thrust above sea level before most of the rest of Oregon (Kay, 1955). Volcanism and glacial advances have not greatly affected the area, and soil and floral development has proceeded without interruption.

1. Geologic History

The majority of the Province is metamorphosed sediments of various ages and origins with intrusions of granitic and ultrabasic materials. The episodes that built the Sierra Nevada also produced small intrusions of granitics and dioritics as in Grants Pass and Lake Mountain respectively (Wells, et al, 1949). The granitics pushed through the existing sediments and can be found as islands of acidic material throughout the Province. The ultrabasic serpentine and peridotite was also pushed through and thrust upon the sediments as evidenced by the many small islands of serpentine in the Province as well as the Josephine peridotite mass that covers over four townships west of the Illinois Valley (Vale 1978). The resultant jigsaw pattern ranges from acidic to basic-igneous and harbors a variety of metamorphosed volcanics and sediments.

Each parent rock produced a variety of soils, a variety of habitats and consequently a variety of plant communities. Each with a slightly different complement of plants which react differently to fire.

2. Climatic History

The long-term climatic trend is thought to be cooling and drying. Therefore, when the Province was formed the climate was much hotter and wetter. In addition, the marine influence was universal because the low relief did not block the inland flow of warm oceanic moisture.

Climatic fluctuation interrupted long-term trends enough to effect two major floral migrations. Invasion of the Artic and Sierra flora occurred when the climate significantly cooled then warmed, respectively. With additional uplift the mountains became a barrier to inland marine flow, developing significant climatic differences between coastal and inland sites. The uplift also provided elevational stratification. The variety of habitats thus increased and species separation began. The true firs, for example, occupied the inland and high elevation sites and the hemlocks and redwoods occupied the lowland and coastal sites where summer moisture was available.

3. Glacial Advances

Sporadic alpine glaciation produced additional habitats as concavities were carved in north slopes and glacial till was deposited (Flint, 1971). No species within the Klamath Province are known to have become extinct because of glaciation. In fact, the Province with its variety of habitats was considered a refuge for migrant species during the glacial periods. About two thousand years after the last and largest glacial advance, approximately eight thousand years ago, a hot and dry climate dominated the area. This period was called the xerothermic (Hansen, 1955). It lasted approximately four thousand years and was the last major climatic event affecting the floral development in the Province. The extent and intensity of fire during the xerothermic was great.

4. Floral History

Redwood, some of the cedars, and cypress most likely developed in the area after the tree and ferns. Relief was low and the climate was hot and wet. Redwood dominated most of Oregon. Long-term climatic warming brought the ancestors of conifers such as sugar pine, Jeffrey pine, incense-cedar, and Shasta red fir into the area from the Sierra area and Pacific silver fir, Alaska yellow-cedar, and western white pine from the north during cold periods. Only a few stands of the northern flora remain, possibly because of the relatively hot, dry weather of today (Axelrod, 1976).

As relief increased, the original flora enriched by the "invaders" were stratified by their efficiency and tolerance. Shasta red fir, white fir, mountain hemlock, western white pine, and Brewer spruce occupied the higher inland sites characterized by cool conditions. Redwood, Port-Orford-cedar, and western redcedar inhabited the low, wet, coastal areas.

The hardwoods developed during an era of plentiful summer moisture. As uplift caused the drying of the climate inland many hardwoods such as birch, beech, basswood, and elm became extinct in this area. Others such as red alder, California-laurel, bigleaf maple, and tanoak adapted but were pushed toward the ocean on the moist sites (Axelrod, 1976).

The glacial advances caused a massive southern movement of trees, shrubs, and herbs. At that time redwood ranged into northern Mexico (Axelrod, 1976). Again the area was enriched with new plants, this time from the north. Four thousand years later the xerothermic period brought in plants from the south. The most notable are the chaparral species such as manzanita, canyon live oak, California black oak, white oak, and ceanothus. At the peak of the xerothermic they occupied much of the Willamette Valley, southwestern Washington and western parts of the Columbia Gorge. They receded during the Little Ice Age (approximately 1300 - 1850) but many areas still have a chaparral component. This component of the chaparral is now part of the Province lowland flora (Detling, 1961).

5. Present Setting

In addition to the geologic and floristic diversity, the Province is influenced by three other factors. First, the Pacific coast high pressure system dominates the weather pattern for much of the summer. Secondly the global position is subjected to both cold storms from the north and warm tropical storms from the south. For example, in February of 1981, Oregon Caves National Park recorded a maximum temperature of 15°C (60°F) and a minimum of -4°C (24°F). During that month the park received precipitation in the amounts of 18 cm (7 in) of rain and 48 cm (19 in) of snow.

Incoming storms are not uniformly received across the landscape. Unlike the Cascades and the coast ranges which drain east to west, there is no recognizable pattern to the major drainages of the Siskiyou Mountains. Therefore, some drainages preferentially intercept the cold storms while others the warmer storms. Summer marine flow is also differentially received. For example, Grayback Creek which is in the Rainshadow climatic zone (Figure 2) commonly has fog and high humidity during the summer.

Thirdly, the Siskiyou's form a high elevation east to west land bridge between the Coast Range and the Cascade Range. This allows species to migrate along the mountain crests from the south and the north, and to mix, forming a marine inland gradient with a variety of habitats.

6. Recent Disturbance

a. Fire

Lightning and Indians ignited fires of an unknown periodicity during prehistorical time. But when gold was discovered in Oregon a few years after the California gold rush in 1849, the influx of miners, settlers, and trappers completely altered the existing patterns of fire ignition and burning. In the mid 1800's miners and trappers were responsible for frequent and extensive fires. According to Lieberg (1900) and Haefner (1912) the settlers started 95% of the fires and the Indians and lightning were responsible for remainder.

Recent fire occurrence shows different trends. Since about 1916 National Forest firecrews have been actively and effectively suppressing fires. The high frequency of fire has been reduced, the rate of fuel buildup has increased, and climax tree species are making a come back.

b. Ignition Source

A site will burn only when fuel and weather conditions are amenable and if there is an ignition source. Lightning is an effective ignition source but does it provide an opportunity for all sites to burn? Figure 3 displays the lightning caused fires on the Siskiyou National Forest between 1940 and 1959. The pattern is dense and relatively uniform. The density is understandably lowest in the Coastal and Fog Belt zones, yet ignitions were numerous considering the data is for only a 20 year period and less than 10% of the strikes actually caused a fire that was recorded and manned.[2/] Thus, given a 100 year rotation and a 500% greater density than shown in Figure 3, it is almost certain that all sites will have the opportunity to burn if fuels are ample and dry.

2/ Personal communication, Wayne Spencer, Siskiyou National Forest, Supervisor's Office, Fire Staff.

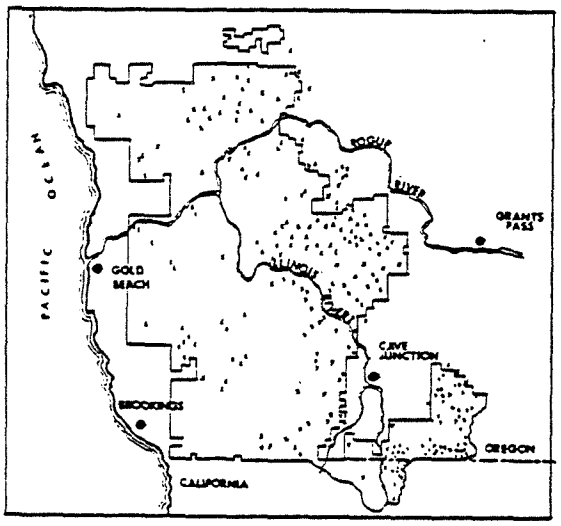


Figure 3 Recorded lightning caused fires on the Siskiyou National Forest for 1940 - 1959.

c. Sheep

Sheep grazing has been a major influence on the vegetation of the Klamath Province, particularly in the high elevations. Sheep grazed the Ashland Reserve from 1870 to at least 1924 (LaLande, 1980). In 1903, a typical year, 103,000 sheep and 7,500 cattle grazed along the backbone of the Siskiyou mountains between where Interstate 5 and U. S. Highway 199 are now located. By 1917 most meadows along the Siskiyou crest were "badly depleted" (Brown, 1960). After World War I reductions were progessively made in an attempt to restore the range resource to good condition. However, many areas along the crest continue to be in poor condition.

V. PLANT SERIES, PLANT ASSOCIATION AND FIRE

A series is an aggregation or association of plants that is dominated by specific climax species. For example, the Douglas-fir/ocean spray association (PSME/HODI) and the Douglas-fir/salal association (PSME/GASH) are both members of the Douglas-fir series. Each series usually occurs on significantly different environments. Douglas-fir, for example, is climax on much drier sites than western hemlock. Therefore a series, although conceptual, can be used for environmental indications.

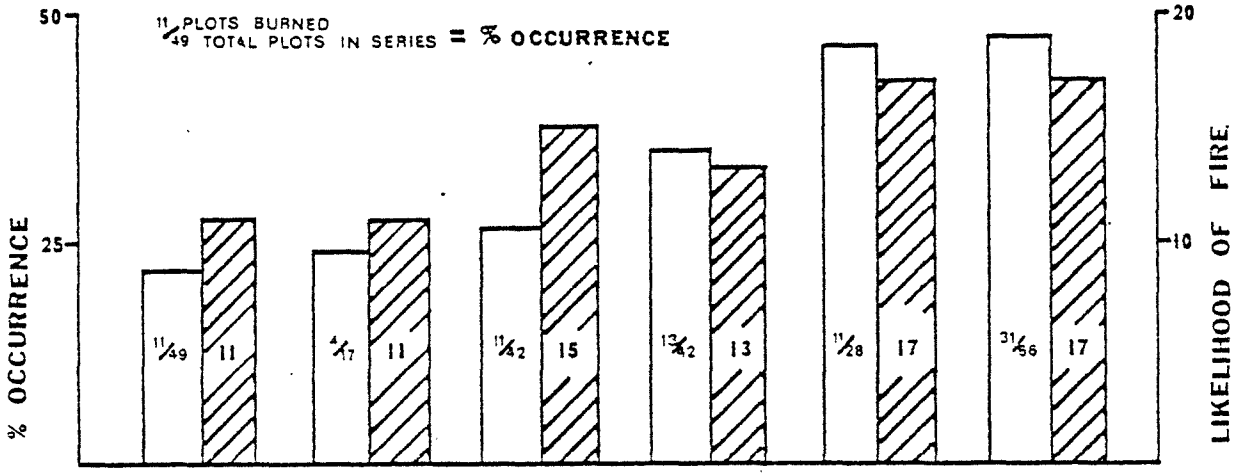
The fire regime differs significantly between series. Because of the differing environments; the number of times fire occurs in a series and the intensity at which it occurs, i.e. the fire regime, depends on the fuel characteristics and weather conditions within the series.

In order to better understand the Province fire regime, we attempted to predict the occurrence of fire based on the average elevation, aspect, amount of litter fall and basal area production by the series found in the Rainshadow zone. We used these variables to relate weather and fuel conditions because they were part of our standardized ecological data set and are easy to measure. Table 1 summarizes this model for predicting fire occurrence. The Table gives the average value and ranking for each of the variables by plant series.[3/] The ranking was based on the probability of fire occurrence. The lower the ranking the lower the probability of fire. Thus, the sum of the rankings gives the relative theoretical probability of a fire occurring within this series, using the last 200 years as the base.

The greatest average litter buildup was found in the Douglas-fir series. It was ranked sixth because the greater the amount of fuel the greater the probability of fire. The same rationale holds for basal area production. The Jeffrey pine series ranks the lowest because it produces very little fuel and is least likely to burn based solely on basal area. The Port-Orford-cedar series has the highest average basal area production and is ranked the highest. However, it occurs on north aspects in wet concavities and is therefore less likely to burn than the Douglas-fir series which occurs on the average at lower elevation, hotter aspects.

When the model is compared to the actual fire occurrence within the series, the correspondence is about 72% (Figure 4). Thus, the risk of fire can be predicted about 72% of the time using the average series value of the four variables in Table 1. Generally the higher the sum of the ratings the higher the occurrence of fire, except with Port-Orford-cedar. The model predicts a higher occurrence than was actually observed. This deviation can be explained by Port-Orford-cedar's extreme dependence on available moisture, and its preference for streamsides, topographic concavities, and areas with high occurrence of fog (Atzet, 1979; Zobel and Hawk, 1980). This favorable microclimate accounts for the high basal area and correspondingly high ranking, with the low occurrence of fire. The probability of fire carrying after ignition is low.

3/ Averages for all series are not yet available.



	PARAMETER	ABMAS	PIJE	CHLA	LIDES	PSME	ABCO
Fuel loading indicators	Litter (% ground cover)	47 (5)	4 (1)	34 (3)	18 (2)	62 (6)	45 (4)
	Total Basal Area (square feet)	328 (3)	215 (1)	389 (6)	331 (4)	321 (2)	358 (5)
Fuel drying indicators	Elevation (feet)	519 (1)	363 (4)	394 (3)	315 (6)	343 (5)	441 (2)
	Aspect (coded[1/])	31.7(2)	28.2(6)	30.9(3)	36.9(1)	30.3(4)	27.8(6)
	Likelihood (of rankings)	(11)	(11)	(15)	(13)	(17)	(17)

1/ Aspect codes range from 40 (northeast) to 20 (southwest). The values increase in both directions from southwest to northeast.

TABLE 1. Likelihood of fire occurrence by vegetation series in the Upper Illinois River Drainage based on ranking of fuel loading and fuel drying indicators. Mean values are used.
(From Atzet 1979).

VI. PLANT SERIES OF THE SISKIYOUS

There are at least eleven major series in the study area. In order from the cold, wet, high elevation environment of the Eastern Siskiyou zone to the warm, dry, low elevation environment of the Rainshadow zone they are the mountain hemlock (TSME), Shasta red fir (ABMAS), white fir (ABCO), Port-Orford-cedar (CHLA), Jeffrey pine (PIJE), Douglas-fir (PSME), ceanothus/oak, and ponderosa pine (PIPO) series. Traveling westward from the Rainshadow (Figure 2) through the Coastal zone the tanoak (LIDE3) and western hemlock (TSHE) series are found. The Sitka spruce (PISI) series is not a significant component of the study area.

Each series has unique vegetation, environment, and fuel characteristics which will be discussed separately and summarized in Appendix B.

1. The Mountain Hemlock Series

Mountain hemlock (Tsuga mertensiana) is a climax dominant on north-facing glaciated sites and on extremely cold, high elevation sites with a short growing season. The glaciated sites are typically cirque-like topography with shallow soils on glacial till. They can occur below 1,660 m (5,400 ft) where snow drifts can commonly be found through July. The high elevation sites around 2,133 m (7,000 ft) can be on any aspect, any slope, and any parent material. Soils are loam to silt loam and average 100 cm (40 in) in depth.

Mountain hemlock dominates both the overstory and the understory with canopy cover averaging 70%. Quite often the shrubs and herbs total less than 10% cover. Sadler oak (Quercus sadleriana) and one-sided pyrola (Pyrola secunda) are the dominants in the shrub and herb layers respectively.

Although lightning provides ample opportunity for ignition, (Figure 3) little evidence of fire was found. The cold, moist environment and the tolerant nature of mountain hemlock combine to dampen the effects of lightning. In addition to the lack of dry litter, the series often lacks understory (live fuel) and, therefore, a fuel ladder.

As the series grades into the Shasta red fir series subtle but significant changes take place.

2. The Shasta Red Fir Series

The Shasta red fir series (ABMAS) occupies an elevational zone slightly lower than the mountain hemlock series, is more extensive, and is not confined to unique topographic positions. The overstory and understory is composed of Shasta red fir (Abies magnifica shastensis) and mountain hemlock. The shrub layer is dominated by Sadler oak and the herb layer by one-sided pyrola. The climate differs enough to have Shasta red fir dominating the regeneration, a significant cover of big whortleberry (Vaccinium membranaceum) in the shrub layer, and a rich herb layer.

Because Shasta red fir is less tolerant than mountain hemlock, it commonly sheds needles and naturally prunes branches creating a high rate of fuel buildup. The Shasta red fir series also produces more biomass than the mountain hemlock series. Tree boles often end up on the forest floor as fuel sooner and in greater tonnage than mountain hemlock. In addition, the fuel cures faster in the drier habitat.

Comparatively, the species tolerance and reaction to fire differ. Shasta red fir has a higher tolerance to heat and its slight pioneer tendencies allow it to survive and efficiently seed burned areas. Mountain hemlock on the other hand is easily killed and reproduces best under a canopy in organic material. Therefore, Shasta red fir can tolerate occasional light fire and has historically encroached in mountain hemlock's domain. With the advent of efficient fire control, Shasta red fir is losing dominance to both mountain hemlock at higher elevations and white fir at lower elevations.

3. The White Fir Series

The white fir series (ABCO) is the most extensive and variable in the study area. It occupies the widest range of elevations, aspects, and slopes. The majority of the series occupies a belt between 1,200 m (4,000 ft) and 1,900 m (6,000 ft) fingering into the Shasta red fir series above and mixing with the Douglas-fir and tanoak series below. It does not often occur on soils shallower than 50 cm (20 in). It occurs on parent materials that have developed into loamy or finer textured soils.

The overstory tree layer is dominated by Douglas-fir (Pseudotsuga menziesii). White fir (Abies concolor) occurs in the overstory on sites where fire disturbance has been mild or nonexistent. These older trees often have deep fire scars and heart rot. White fir's thin bark provides little insulation for the cambium during mild underburns until it reaches diameters greater than 8 inches. Smaller trees are either killed directly or weakened and later die from secondary infection of insects or disease (Appendix B). Moreover, the tolerant nature of white fir, which allows branches to survive close to the ground, makes the lower crown a fire ladder to the upper crown.

White fir's "strategy" for site occupation relates directly to its shade tolerance. Its high crown ratio limits light for the regeneration of competitors, reduces the rate of external nutrient cycling and internal loss (ties up available nutrients), reduces the rate of fuel buildup, reduces the rate of fuel drying, increases the rate of organic decomposition, and provides an organic seed bed for germination. Intolerant Douglas-fir, presently the overstory dominate of the series, is self-pruning, and often sheds its needles and tends to increase the rate of fuel buildup and fuel drying. Its nutrient cycling processes are more loose than white fir and it prefers mineral seed beds for germination. Before 1920 tne fire regime favored Douglas-fir. Even though the climate has steadily warmed increasing the probability of fire, fire control measures have greatly reduced risk since the early 1900's. The overall result has favored the reestablishment of white fir.

Ponderosa pine (Pinus ponderosa), sugar pine (P. lambertina), and incense-cedar (Calocedrus decurrens) commonly occur in the overstory of the series. All are considered fire resistant (Minore, 1979). Ponderosa pine only occurs in the driest communities of the series and has been decreasing in cover with increased fire control. Sugar pine and incense-cedar both occur sporadically but incense-cedar has a slight affinity toward basic soil conditions. Baker cypress (Cupressus bakeri) and Brewer spruce (Picea brewerana), two important endemic conifers, are found in this series. Both are relics from a warmer, wetter climate. They exist today in the midslope concavities where temperature extremes are somewhat dampened and atmospheric moisture is plentiful. Brewer spruce has regenerated well in areas where fire occurs very sporadically. It does not need fire to stimulate regeneration as does Baker cypress, a closed cone conifer.

The understory dominant is, of course, white fir. Along with the conifers mentioned above, Pacific madrone, (Arbutus menziesii), Pacific yew (Taxus brevifolia), and tanoak (Lithocarpos densiflorus) are common in the understory. However, they are present for different reasons. Most of the Pacific madrone is from 70 to 100 years old and was initiated by fire at the turn of the century. Much of the Pacific yew survived the fires because it inhabits the wettest concavities which are not often affected by fire. The tanoak postdates fire and is becoming more prominent as an understory species within the series. Its lack of frost tolerance has relegated it to a minor position.

Dwarf Oregon grape (Berberis nervosa), rose (Rosa spp.), and snowberry (Symphoricarpos mollis) are the climax dominants in the shrub layer. They represent undisturbed conditions. Manzanitas (Arctostaphylos spp.) (except for pinemat manzanita), ceanothus (Ceanothus spp.) (except for squaw carpet), cherry (Prunus spp.), and California black oak (Quercus kelloggii) indicate disturbance. They are a common component of a Douglas-fir series where fire occurrence is higher, but are dependent on disturbance within the white fir series.

The series is herb rich. Over 200 herbaceous species can be found. Vanilla-leaf (Achlys triphylla) and prince's-pine (Chimaphila umbellata) are the most common and are insignificant to the overall fire pattern.

4. The Port-Orford-cedar Series

The Port-Orford-cedar series (CHLA) is limited to narrow stringers along stream channels inland and either wet, boggy drainages or ultrabasic parent materials on the coast. Elevation, aspect, and slope are not critical to its reproductive capacity. Apparently it competes well wherever soils are saturated for much of the growing season, and it has a tolerance for ultrabasic soil. Soil textures range from sandy soils on alluvial terraces to clay soils on serpentine.

Douglas-fir, white fir, tanoak, and golden chinquapin (Castanopsis chrysophylla) are common overstory and understory associates, western hemlock (Tsuga heterophylla) occurs less often. Basically shrub composition is the same as the white fir series inland, but rhododendron, dwarf Oregon grape, salal (Gaultheria shallon), and red huckleberry ((Vaccinium parvafolium) appear on the coastal sites. The shrub and herb composition on the serpentine sites is unique. Western azalea (Rhododenron accidentalis), California coffeeberry (Rhamnus californica), California-laurel (Umbellularia californica), and a variety of grasses characterize the vegetation on ultrabasic soils. Port-Orford-cedar (Chamaccyparis lawsoniana) is rare where fire is common, nevertheless, its resistance is high. Its thick bark prevents its demise but it is often

catfaced. Trees in drainages and on serpentine soils are quite often a good source for fire dating. They scar easily, respond well to the reduction of competition, and the characteristic annual ring pattern is evident (Appendix B).

5. The Jeffrey Pine Series

The Jeffrey pine series (PIJE), a special case, is entirely confined to ultrabasic parent materials. It is not the sole climax dominant on ultrabasics, especially near the coast where abundant moisture modifies the soil limitations. Coastal ultrabasic sites often have Port-Orford-cedar as the dominant climax species.

Associates on the drier sites include incense-cedar, huckleberry oak (Quercus vaccinifolia), silk tassle (Garrya spp.), and serviceberry (Amelanchier pallida). On the wetter sites California-laurel, California coffeeberry, and western azalea are common.

Fire infrequently occurs in this series. Although most sites are open and quick to dry, little fuel is produced.

Moreover, fuel continuity is usually lacking. The light fires in this series have not in most cases significantly altered species composition.

6. The Douglas-fir Series

The Douglas-fir series (PSME) is one of the least extensive series. It exists as an edaphic climax much as it does in the Cascades, (Means, 1980) on deep loamy soils where exposure, slope and aspect produce extreme evapotranspirational demand. Most stands are disjunct and the series cannot be thought of as an elevational band. The series can occur at elevations of 300 to 1,200 m (1,000 to 4,000 ft) and on slopes from 20 to 80% with an average of 48%. Soil depth averages 78 cm (31 in) but many stands have soils greater than 127 cm (50 in).

Douglas-fir dominates the overstory with very little competition. It associates with Pacific madrone, golden chinquapin, canyon live oak (Quercus chrysolepis), tanoak, and white fir in the understory. The Pacific madrone indicates disturbance, the chinquapin indicates limited nutrition (McKee, 1979), the canyon live oak indicates shallow soils, and the white fir occurs with less than 5% cover and indicates the best sites of the series (Appendix B). The common shrubs are dwarf Oregon grape, poison oak, and hairy honeysuckle. Dwarf Oregon grape usually occurs on the better sites of this series with tanoak. Poison oak (Rhus diversiloba), hairy honeysuckle (Lonieera hispidula) and canyon live oak co-occur on shallow soils where reforestation is extremely difficult.

Douglas-fir tends to produce conditions that favor fire wherever it occurs. With frequent or intense fire, site productivity can be significantly reduced. Reduction in soil depth, organic material, soil structure, and waterholding capacity can restrict Douglas-fir from the site and bring about invasion by the chapparal as during the xerothermic.

7. The Ceanothus, Oak, and Ponderosa Pine Series

Detling (1961) and Hickman (1972) described a belt in and immediately above the interior valley floor. Diurnal and seasonal temperature variation is extreme. During the growing season temperatures may vary from a -4° C (24°F) to 43° C (110°F). Precipitation is less than 70 cm (30 in) but soils are often deep alluvial soils that support ponderosa pine as climax. Douglas-fir and California black oak are common associates on the more productive sites; California black oak is usually seral. California black oak also occurs on other series in areas that have been repeatedly disturbed or where soil characteristics are limited. White oak (Quercus garryana) can be climax on xeric sites and wedgeleaf ceanothus (Ceanothus cuneatus) is climax on the poorest sites (Detling, 1961).

Successional relationships in this belt are tentative. Disturbance is so frequent that climax composition can only be inferred. Detling (1961) feels that much of the chapparal is dependent on fire and is successional to ponderosa pine.

There are three commonly occurring ceanothus species in the ponderosa pine series that can be ranked as to their indication of site productivity. Wedge-leaf ceanothus is indicative of the least productive sites as mentioned above. It sprouts readily but does not seed as well as deerbrush ceanothus (C. integerrimus). Deerbrush occurs on intermediate sites and snowbrush (C. velutinus), the most prolific of the trio, occupies the best sites. Snowbrush also occurs after disturbance on good sites in many other series. Snowbrush is well-known for its ability to colonize after fire from extremely old viable seed (Gratkowski, 1962). Thus,

it has developed an efficient survival strategy for the better sites where fire is less common and soil is more productive. All three species fix nitrogen.

Several manzanitas are common in this series. All pioneer after disturbance, but some do not crown sprout (Schopmeyer, 1974). Hoary (Arctostaphylos caneseens) and whiteleaf manzanitas (A. viscida) do not crown sprout after fire. Greenleaf manzanita (A. patula), usually found on the better sites, has a basal burl and will sprout (Munz and Keck, 1959). Pinemat manzanita (A. nevadensis) is not found in this series. It is common at high elevations and indicates rocky, cold, shallow soils. The manzanitas are extremely flammable and often comprise 50% of the total fuel available in this series. Obviously they also contribute greatly to fuel continuity. These series are not often used for wood fiber production.

8. The Tanoak Series

In the western Siskiyous tanoak is climax where both soil and atmospheric moisture is plentiful. The series shows preference for northerly aspects and fine textured soils. Average elevation for the series is 945 m (3,100 ft). The tanoak series (LIDE3) is generally found at midslope. This combination of elevation and slope position seldom experience great temperature extremes. The typical inland stand is composed of a mixture of hardwoods: golden chinquapin, tanoak, Pacific madrone, and bigleaf maple (Acer macrophyllum); and conifers: Douglas-fir, white fir, sugar pine, incense-cedar, and Pacific yew. Tanoak overwhelmingly dominates the understory (50% average cover) with golden chinquapin developing less than 25% cover. Douglas-fir and Pacific madrone are common in the understory. And dwarf Oregon grape, salal, and vine maple (A. circinatum) are the dominate shrubs with twinflower (Linnaea borealis longiflora), whipple vine (Whipplea modesta), and vanilla-leaf are the dominant herbs.

Coastal communities have a lower average elevation, deeper soils and occur on all aspects. Temperature extremes are moderate, similar to the western Siskiyou communities.

Coastal associates are quite different. Dwarf Oregon grape and salal co-occur in some communities as on the inland communities but rhododendron and evergreen huckleberry (Vaccinium ovatum) tend to dominate. On the lower, more moist site, California-laurel becomes a prominent member of the community and dwarf Oregon grape and salal are absent. Beargrass (Xerophyllum tenax), bracken fern (Pteridium aquilinum), and swordfern (Polystichum munitum) are constant members of herbaceous layer. Bracken fern is ubiquitous but beargrass and swordfern split between the dry and the moist sites respectively.

In the Western Siskiyous fire periodicity is estimated as 20 years for the series. Coastal periodicity is about 3 times longer. There is some evidence (e.g., widespread even-aged stands) that although the coastal fire-free periods are longer, the fires are much more intense.[6/] Possibly the longer time between fires allows a greater fuel accumulation; therefore, greater heat yield. Or the extreme weather conditions that are required for burning on the coastal sites support more intense fires.

Tanoak itself is very tolerant and does not produce much coarse litter. Leaf fall is significant but is rapidly decomposed due to the high moisture and warm coastal temperatures associated with the series. Douglas-fir is still plentiful in the overstory on most sites and contributes significantly to the fuel load as such fuel is not a limiting factor. Tanoak is extremely sensitive to fire. The aboveground portions are easily killed. However, it produces an underground burl that will survive repeated fires and still have the energy to sprout.[7/]

9. The Western Hemlock Series

The tanoak (LIDE3) and the western hemlock series (TSHE) exists side by side in the coastal zone. Western hemlock (Tsuga heterophylla) is climax near the coast where evapotranspirational demand is low and in concavities where cold air shortens the growing season. Tanoak dominates the inland sites where the marine influence lessens and where cold does not limit its competitive ability. Thus, western hemlock is mostly dominant in the Fog Belt zone and its range noticeably widens inland in that zone. The average elevation for the series is 300 m (984 ft). The aspects and slopes vary and

6/ Periodicity is determined by the number of fires that left a scar on the cambium. Fires with insufficient heat to damage the cambium may go unrecorded. Thus the estimate is considered conservative.

7/ Personal communications, Dr. John Tappenier, Assoc. Professor, Oregon State University.

the soil depth averages over 127 cm (50 in). Moisture is the overwhelming environmental factor that masks all others.

The overstory associates range from Douglas-fir to redwood (Sequoia sempervirens) and include Port-Orford-cedar, tanoak, western redcedar (Thuja plicata), and grand fir (Abies grandis). Major understory trees include tanoak and Port-Orford-cedar with occasional western redcedar, Douglas-fir, bigleaf maple, and red alder (Alnus rubra). The shrub layer of most communities is dominated by rhododendron, dwarf Oregon grape, and salal. But in areas where this trio is absent California-laurel, California hazel, and vine maple tend to co-occur and western redcedar becomes more competitive with western hemlock. Swordfern, and oxalis (Oxalis oregana) are the everpresent herbaceous components; however, there are many herbs that occur sporadically.

Fire occurrence in this series is significantly reduced by the marine climate. In 1981 when Grants Pass was experiencing record temperatures, Powers was in the fog and drizzle. Nevertheless, a majority of the coastal plots showed evidence of burning. Even in the fog belt many western hemlock trees were fire scarred and several large intense fires were recorded. The risk of fire is low but litter accumulation and weather conditions will eventually produce a high risk situation that must be a part of management consideration.

VII. THE SUMMARY

The complex Klamath Geological Province is composed of young and old geologic material that include igneous, and sedimentary materials that have been metamorphosed to varying degrees. Floral development on this parent rock has been altered several times by floral invasions from northern and southern sources. The resultant flora has survived cold, wet, hot, and dry periods to produce a complex of genetic information well adapted to the area.

Today the Pacific coast high pressure system which often lies at this latitude is a major influence in drying during the summer. The area is otherwise subjected to weather originating from both the Bering Sea and tropical sources, and the fluctuation can be quick and extreme. The jumbled topography helps to produce a variety of micro-climatic regimes that range from marine to continental eastwardly. The transverse orientation of the range joins the Cascades, Sierra Nevadas, and the Coast Ranges of Oregon and California. This land bridge allows mixing of the flora and continues to foster mixing of genetic material.

An overview of the environment, flora, and fire regime is given for the mountain hemlock, Shasta red fir, white fir, Douglas-fir, Jeffrey pine, Port-Orford-cedar, ceanothus, oak, ponderosa pine, tanoak, and western hemlock series. Each series differs in the occurrence and risk of fire depending on its ability to produce and dry fuel (see Appendix 3).

LITERATURE CITED

Arno, Stephen F. Forest fire history in the northern Rockies. J. Forestry 78(8):460-465; 1980.

Atzet, Thomas. Description and classification of the forests of the upper Illinois River drainage of southwestern Oregon. Corvallis, OR: Oregon State University; 1979. 211 p. Ph.D. Thesis.

Axelrod, Daniel I. History of the coniferous forests, California and Nevada. University of California Publications in Botany, Vol. 70; 1976. 62 p.

Brown, Carrol. History of the Rogue River National Forest. Vol. 1. 1960.

Cater, F. W.; Wells, F. G. Geology and mineral resources of the Gasquet Quadrangle, California-Oregon. U.S. Geol. Survey Bull. 995-c; 1954: 79-133.

Detling, L. E. The chaparral formation of southwestern Oregon, with considerations of its postglacial history. Ecology 42:348-357; 1961.

Flint, F. F. Glacial and quaternary geology. John Wiley and Sons; 1971. 892 p.

Garrison, A.; Skovlin, J. M.; Poulton, C. E.; Winward, A. H. Northwest plant names and symbols for ecosystem inventory and analysis (4th ed.). Gen. Tech. Rep. PNW-46. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1976. 263 p.

Gratkowski, H. J. Heat as a factor in germination of seeds of Ceanothus velutinus var. laevigatus. Ph.D Dissertation Oregon State Univ. 1962.

Haefner, H. E. Chaparral areas on the Siskiyou National Forest. Society American Foresters Proceedings 7:82-95; 1912.

Hall F. C. Ecology of natural underburning in the Blue Mountains of Oregon, Publication R6-ECOL-79-001: Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Region; 1977. 11 p.

Hansen, H. P. Postglacial forests in south-central and central British Columbia. Am. J. Sci. 253:640-658; 1955.

Hemstrom, Miles A. Fire in the forests of Mount Rainer National Park. In: Proceedings, Second Conference of Science Research in the National Parks; 1979 Nov. 26-30; San Francisco, CA. Washington, DC: American Institute Biological Science and U.S. Department of Interior, National Park Service; 1980.

Hickman, Eugene. Ecological site descriptions for Big Butte coordinated resource management plan. U.S. Department of Agriculture, Soil Conservation Service; 1972.

Kay, M. The origin of continents. Sci. Am.; Sept. 1955.

LaLande, Jeffrey M. Prehistory and history of the Rogue River National Forest: a cultural resource overview. U.S. Department of Agriculture, Forest Service, Pacific Northwest Region; 1980. 297 p.

Lieberg, John B. Cascade Range and Ashland Forest Reserves and adjacent regions. U.S. Geological Survey 21st Ann. Rep. 1899-1900, Part 5, Forest Reserves; 1900:211-498.

McKee, Arthur. Castanopsis chrysophylla-giant chinquapin. Review Draft for Silvics Manual, U.S. Department of Agriculture, Agric. Handb.; 1979. 19 p.

McNeil, Robert C.; Zobel, Donald B. Vegetation and fire history of a ponderosa pine-white fir forest in Crater Lake National Park. Northwest Science 54(1): 30-46; 1980.

Means, Joseph Earl. Dry coniferous forests in the western Oregon Cascades. Corvallis, OR: Oregon State University; 1980. 268 p. Ph.D. Thesis.

Minore, Don. Comparative autecological characteristics of northwestern tree species-a literature review. Gen. Tech. Rep. PNW-87. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1979. 72 p.

Munz, P. A.; Keck, D. D. A California flora University of California Press, Berkley; 1959. 1981 p.

Schopmeyer, C. S. Seeds of woody plants of the United States. Ag. handbook No. 450; 1974, 883 p.

Shinn, Dean A. Historical perspectives on range burning in the inland Pacific northwest. J Range Mgmt. 33(6):415-423; 1980.

Vail, S. G. Geology and geochemistry of the Oregon mountain area, southwestern Oregon and northern California. An investigation of the origin and development of a Jurassic Ophiolite in the Klamath Mountains. Corvallis, OR: Oregon State University; 1977. 135 p. Ph.D. Thesis.

Vale, Thomas R. Tree invasion of montane meadows in Oregon. The American Midland Naturalist 105(1):61-69; 1981.

Waring, R. H. Forest plants of the eastern Siskiyous-their environmental and vegetational distribution. Northwest Science 43(1):1-17; 1969.

Wells, F. G.; Holts, P. E.; Cater, F. W. Preliminary description of the Kerby Quadrangle, Oregon. Oregon Department of Geology and Mineral Resources Bulletin No. 40; 1949. 23 p.

Zobel, Donald B.; Hawk, Glenn M. The environment of Chamaecyparis lawsoniana. Oregon State University, Corvallis; 1980. 53 p.

APPENDIX A

PLANT LIST

Common Name	Scientific Name	Code[1/]
Trees		
Alaska yellow-cedar	Chamaecyparis nootkatensis	CHNO
Baker cypress	Cupressus bakeri	CUBA
Basswood	Tilia spp.	TILIA
Beech	Fagus spp.	FAGUS
Brewer spruce	Picea breweriana	PIBR
Bigleaf maple	Acer macrophyllum	ACMA
Birch	Betula spp.	BETUL
California black oak	Quercus kelloggii	QUKE
California-laurel	Umbellularia californica	UMCA
Canyon live oak	Quercus chrysolepis	QUCH
Cherry	Prunus spp.	PRUNU
Douglas-fir	Pseudotsuga menziesii	PSME
Elm	Ulmus spp.	ULMUS
Golden chinquapin	Castanopsis chrysophylla	CACH
Grand fir	Abies grandis	ABGR
Hemlock	Tsuga spp.	TSUGA
Incense-cedar	Calocedrus decurrens	CADE
Jeffrey pine	Pinus jefferyi	PIJE
Lodgepole pine	Pinus contorta	PICO
Mountain hemlock	Tsuga mertensiana	TSME
Pacific madrone	Arbutus menziesii	ARME
Pacific silver fir	Abies amabilis	ABAM
Pacific yew	Taxus brevifolia	TABR
Ponderosa pine	Pinus ponderosa	PIPO
Port-Orford-cedar	Chamaecyparis lawsoniana	CHLA
Red alder	Alnus rubra	ALRU
Redwood	Sequoia sempervirens	SESE2
Shasta red fir	Abies magnifica shastaensis	ABMAS
Sugar pine	Pinus lambertina	PILA
Tanoak	Lithocarpus densiflora	LIDE3
Vine maple	Acer circinatun	ACCI
Western hemlock	Tsuga heterophylla	TSHE
Western redcedar	Thuja plicata	THPL
Western white pine	Pinus monticola	PIMO
White fir	Abies concolor	ABCO
White oak	Quercus garryana	QUGA
Shrubs		
Big whortleberry	Vaccinium membranaceum	VAME
California coffeeberry	Rhamnus californica	RHCA
California hazel	Corylus cornuta californica	COCOC
Ceanothus	Ceanothus spp.	CEANO
Deerbrush ceanothus	Ceanothus integerrimus	CEIN
Dwarf Oregongrape	Berberis nervosa	BENE

1/ From Garrison, etal. 1976

Evergreen huckleberry	Vaccinium ovatum	VAOV2
Greenleaf manzanita	Arctostaphylos patula	ARPA
Hairy honeysuckle	Lonicera hispidula	LOHI
Hoary manzanita	Arctostaphylos canescens	ARCA
Huckleberry oak	Quercus vaccinifolia	QUVA
Manzanita	Arctostaphylos spp.	ARCTO
Ocean spray	Holodiscus discolor	HODI
Pinemat manzanita	Arctostaphylos nevadensis	ARNE
Poison oak	Rhus diversiloba	RHDI
Prince's-pine	Chimaphila umbellata	CHUM
Red huckleberry	Vaccinium parvifolium	VAPA
Rhododendron	Rhododendron macrophyllum	RHMA
Rose	Rosa spp.	ROSA
Sadler oak	Quercus sadleriana	QUSA
Salal	Gaultheria shallon	GASH
Serviceberry	Amelanchier pallida	AMPA
Silktassel	Garrya spp.	GARRY
Snowberry	Symphoricarpos mollis	SYMO
Snowbrush ceanothus	Ceanothus velutinus	CEVE
Squawcarpet ceanothus	Ceanothus prostratus	CEPR
Wedge-leaf ceanothus	Ceanothus cuneatus	CECU
Western azalea	Rhododendron occidentale	RHOC
Whipplevine	Whipplea modesta	WHMO
Whiteleaf manzanita	Arctostaphylos viscida	ARVI

Herbs

Beargrass	Xerophyllum tenax	XETE
Brackenfern	Pteridium aquilinum	PTAQ
One-sided pyrola	Pyrola secunda	PYSE
Oxalis	Oxalis oregana	OXOR
Swordfern	Polystichum munitum	POMU
Twinflower	Linnaea borealis longiflora	LIBOL
Vanillaleaf	Achlys triphylla	ACTR

APPENDIX B

SPECIES CHARACTERISTICS AND THEIR REACTION TO FIRE

SPECIES	CHARACTERISTICS A/	B/	C/	REACTION D/	E/	F/	G/	H/	FUEL I/	J/	ENVIRONMENTAL INDICATIONS AND REMARKS	SPECIES CODE
BAKER CYPRESS	S	SD	M	R	G	M	G		M	M	COLD SHALLOW SOILS	CUBA
BREWER SPRUCE	S	SD	M	M	G	D		H	M	M	COLD WET	PIBR
CALIFORNIA BLACK OAK	ES	SP	M	T	S	T	S	H	L	F	WARM	QUKE
CANYON LIVE OAK	ES-LS	SP	M	M	S	T	S	L	L	F	ROCKY SHALLOW SOILS	QUCH
DOUGLAS-FIR	ES-C	SD	M	R	G	M	G	M	H	H		PSME
GOLDEN CHINQUAPIN	ES	SP	A	T	S	T	S	L	M	M	UNFERTILE DROUGHTY	CACH
INCENSE-CEDAR	ES-LS	SD	A	R	G	L		L	L	F		CADE
JEFFREY PINE	C	SD	A	R	G	L	G	L	L	F	ULTRABASIC SOILS	PIJE
MOUNTAIN HEMLOCK	C	SD	O	M	N	D	N	H	L	F	COLD WET	TSME
PACIFIC MADRONE	ES	SD	M	M	S	T	S	M	H	M	FIRE DISTURBANCE	ARME
PONDEROSA PINE	S-C	SD	M	R	G	L	G	M	H	F	HOT DRY	PIPO
PORT-ORFORD-CEDAR	S-C	SD	A	R		L		L	H	F	WARM WET	CNLA
REDWOOD	S	BT	M	R	G	R	G	L	H	F	WARM WET	SESE2
SHASTA RED FIR	S-C	SD	A	M	N	D	N	H	M	H	COLD	ABMAS
SUGAR PINE	ES-S	SD	M	R	G	L	G	L	H	H	WARM WITH DEEP SOILS	PILA
TANOAK	ES-C	SP	A	T	S	T	S	H	H	F	USUALLY GOOD SITES	LIDE3
WESTERN HEMLOCK	C	SD	O	D	N	D	N	H	H	F	MOIST	TSHE
WESTERN REDCEDAR	C	SD	O	R	N	L	N	L	H	M	WET	THPL
WHITE FIR	S-C	SD	O	D	N	D	N	H	H	M		ABCO
DEERBRUSH CEANOTHUS	ES	SD	M	T					H	M	HOT FIXES NITROGEN	CEIN
DWARF OREGONGRAPE	C	SP	O	M	S	D	N		L	F	GOOD SITES	BENE
EVERGREEN HUCKLEBERRY	S-C	SP		M	S	M	S				WET	VAOV2
GREENLEAF MANZANITA	ES	BT		M	G	T	G		H	M	HOT GOOD SITE	ARPA
HAIRY HONEYSUCKLE	C								L	F	HOT DRY	LOHI
HOARY MANZANITA	ES								H	M	HOT POOR SITE	ARCA
POISON OAK	S	BT		T	S	T	S		L	F	HOT WELL DRAINED ROCKY	RHDI
RHODODENDRON	S-C	SP		M	S	T	S					RHMA
SALAL	S-C	SP		M	S						DRIEST OF MOIST SITES	GASH
SNOWBRUSH CEANOTHUS	ES	SD		M	G	T	G	L	H	M	WARM GOOD SITE N. FIXER	CEVE

A/ SERAL STAGE: ES=EARLY SERAL; S=SERAL; LS=LATE SERAL; C=CLIMAX.
B/ MAJOR REGENERATION MODE: SD=SEED; SP=SPROUT; BT=BOTH METHODS.
C/ PREFERRED SEED BED: O=ORGANIC; M=MINERAL; A=ALL TYPES.
D/ DAMAGE WITH LIGHT BURN: R=RESISTANT; L=LIGHT; M=MODERATE; D=DEATH; T=TOP KILL (DEPENDS ON SIZE).
E/ REACTION TO LIGHT BURN: S=SPROUTING; G=STIMULATE SEEDING OR GERMINATION; N=NONE.
F/ DAMAGE WITH MODERATE BURN: SAME AS D/.
G/ REACTION TO MODERATE BURN: SAME AS E/.
H/ SUSEPTABILITY TO SECONDARY ATTACK: H=HIGH; M=MODERATE; L=LOW.
I/ [illegible] OF BUILDUP: SAME AS H/.
J/ [illegible] TYPE: F=FINE; M=MEDIUM; H=HEAVY.